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A CENTURY OF PROGRESS IN CRYSTALLOGRAPHY*

HERBERT P. WHITLOCK, *American Museum of Natural History.*

Reviewing the history of the modern sciences it appears to us remarkable that in so many instances the person of one individual assembles the scattered observations and deductions of his predecessors, unifies and crystallizes the thought of his epoch and gives to his special branch of learning that impetus which kindling at the fire of his genius, lights his successors along the way to modern scientific attainment. In this way we speak of Newton as the father of mechanical physics; of Cuvier as the originator of comparative zoology, and of Linnaeus as the founder of biological classification.

A name that stands out conspicuously in the period of scientific renaissance included in the seventeenth and eighteenth centuries is that of René Just Haüy, creator of the science of crystallography, and one of the most profound analytical thinkers of this age of intellectual giants.

It has been said that Abbé Haüy obtained his first insight into the realm of natural science through the study of botany and that the symmetries of plant life paved the way in his mind to those more intricate and beautiful symmetries of crystallization which were to render his name renowned. Happening to attend a lecture on mineralogy given by Daubenton at the Muséum d'Histoire Naturelle his interest was aroused in the forms assumed by crystallized minerals.

This new world of inorganic shapes, complex and yet regular, impressed Haüy, fresh from the contemplation of the geometrical symmetry of the forms of plant life, with an apparent lack of orderly arrangement where his scientific instinct assured him that order must exist. How, he reasoned, can the same stone, the same salt, reveal itself in cubes, in prisms, in points without changing its composition to the extent of a single atom, while the roses have

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always the same petals, the acorn the same curve, and the cedar the same height and the same development. In the midst of these speculations the Abbé Haüy had his attention directed to the internal structure of crystals when, by a happy accident, a six-sided prismatic crystal of calcite was broken in his presence into rhombohedral fragments. He rightly conceived these cleavage fragments to be essential to the crystal structure of calcite, and upon them, by a system of diminishing rows, *dêscroissements*, of small rhombohedrons, he found that he could build up most of the solids that comprise the familiar crystal forms of calcite. From this significant observation it was but a step to the idea of developing the "primitive form" from the cleavage fragments of other mineral species, and of these to construct by diminishing layers of crystal particles, each layer having a definite relation to the preceding one, the complex modified crystal combinations that constitute what we now know as crystal habit.

The law of symmetry as announced by Haüy in 1815 may be justly stated to have founded crystallography upon a mathematical, which is equivalent to saying upon a rational, basis. As stated by him this law is as follows: It consists in this, that any one method of decrement (*dêcroissement*) is repeated on all these parts of the nucleus of which the resemblance is such, that one can be substituted for the other by changing the position of this nucleus with respect to the eye, without it (the nucleus) ceasing to be presented in the same aspect.[1]

So epochal was the presentation of this *natural geometry*, that there will appear to any one who will consult the literature of mineralogy in the latter half of the eighteenth and the first half of the nineteenth centuries, a well marked line of distinction between the old and the new, between those who wrote before Haüy published his famous "Essai" and those who succeeded him and profited by his teachings.

There now succeeded in the development of crystallographic science an era of observation in the field of mathematical crystallography. Armed with instruments of steadily increasing refinement and precision the crystallographers of the period between 1820 and 1920 toiled unceasingly at the collection of measurements of the angles between the faces of crystals, and at the consequent identification of "forms" characteristic of the many hundreds of

[1] Memoire sur une loi de Cristallisation.

mineral species subjected to this study. It soon became evident to these workers that the more accurately an angle between certain planes present on a crystal of a definite compound were measured, the closer would the resulting measurement approach to the theoretical value of that angle as calculated by the methods of spherical trigonometry.

The science of crystallography took on a certain resemblance to that of astronomy in that observation checked closely with calculation. As the astronomer is enabled to turn his telescope to a predetermined spot in the heavens and predict with certainty that at a fixed time in hours, minutes and seconds a definite star will be seen at that *exact* point, so the worker in the field of crystallography is enabled to predict that at some angle, accurately calculated in degrees and minutes, the reflected image of a certain crystal face will appear in the exact center of the field of vision of his instrument. Nor does the resemblance altogether stop at this point, for crystallographers soon adopted from astronomy the methods of spherical projection by which they were enabled to represent diagrammatically the crystal faces occurring on a crystal and the symmetrical grouping of them, much as stars are represented on celestial spheres and star maps. So crystallography developed into an exact science, beautiful and supremely satisfying in its coincidences and subtly but compellingly suggestive of some far reaching cause extending back of all of this marvelous order and symmetry. It was inevitable that scientists of this period, impressed with the mathematical exactitude with which the faces constituting the outward semblance of a crystal were disposed in symmetrical grouping, should seek for an explanation of this exactitude in the inner structure of that crystal. And, as the science of physics grew apace, it was equally inevitable that investigators of the middle nineteenth century should direct their attention to the physical properties of crystals as a possible key to ultimate crystal structure. This field proved a very fertile one. Crystal optics showed that light traversing a crystalline fragment reacted in accordance with the symmetry expressed by the disposition of the faces in a completely formed crystal of the substance composing the fragment. Similar results attended the investigation of the transmission of heat and electricity, and finally it was found that weak solvents, properly applied to the smooth faces of crystals would excavate minute pits whose shapes were dependent on the way the particles

of matter that composed those crystals were arranged with respect to one another. All of this led step by step but with inevitable finality to the assumption of theoretical groupings of particles (space lattices, molecular networks), which taken together explained all of the variations of crystal symmetry. Thus from many points of view was the fundamental discovery of the Abbé Haüy checked, elaborated and rationalized.

It would be difficult to exaggerate the skill and insight displayed by the scientists of the early years of this formative period. Armed with instruments and apparatus which would be rejected as inadequate by many a high school student of today, they made up for this inadequacy by a manual skill in the handling of these appliances which, in very many instances, cause their results to stand against the assaults of modern students armed with modern instruments. Let us call to mind a few of the notable men in the field of science known as mathematical crystallography.

William Hyde Wollaston introduced the reflecting goniometer in 1809, thus rendering possible a far more accurate determination of the interfacial angles of crystals than was possible with the contact type of instrument previously in use.

Professor Christian Samuel Weiss of Berlin in 1815 developed a purely geometrical mode of treatment for crystals, and discarding the "mechanical presentation" of Haüy, referred the planes existing on them to certain fundamental lines or axes meeting in the center. Weiss's real contribution to his science was the defining of the isometric, tetragonal, orthorhombic and hexagonal systems.

Professor Frederich Mohs of Freiberg in 1822 added the monoclinic and triclinic system and brought the Weiss geometrical point of view in accord with Haüy's conception of decreased rows of units.

George Amadeus Carl Friedrich Naumann, pupil and successor to Mohs, in 1829 invented the system of crystal symbols that bears his name, and that for sixty years was a standard mode of expressing crystal forms.

The most important work among the early followers of Haüy was done by Professor William H. Miller of Cambridge University, who in 1839 deduced a still simpler and more workable system of crystal symbols, and by projecting the faces of a crystal upon the surface of a circumscribed sphere by means of radii normal to these faces, evolved the great principle of zonal relations in crystallography.

Among workers of the early years of the last century, a name that well deserves mention is that of A. Lévy, an enthusiastic and productive crystallographer, whose three volumes with atlas on the material on the famous Heuland Collection is a classic. Lévy also elaborated Haüy's conception of primitive forms into a system of crystal nomenclature that is still in use among French authors. Another famous name is that of James Dwight Dana, greatest of American mineralogists and crystallographers.

Turning now to what we may designate as the constructive phase of crystallographic research in the nineteenth century, we encounter a group of men who, from the laborious work of the mathematical crystallographers strove to formulate arrangements of the ultimate structural units of crystals that would account for the symmetry displayed, both internally and externally, by these bodies. Although a network of molecular points was conceived by Seeber in 1824, this period may be said to begin with the work of M. L. Frankenheim of Breslau, who eliminated from the problem of the structures assumed by the ultimate particles in space the consideration of the shape of the molecules. In thus breaking free from the hampering restrictions of Haüy's "molecules integrantes" Frankenheim limited his studies to the consideration of possible theoretical networks of points, and in 1842 announced that 15 different symmetrical continuous arrangements were possible.

Auguste Bravais of Paris in 1848 showed that the space lattices of Frankenheim were mathematically logical and reduced their number to 14 by proving two to be identical. So important was this advance that we now ascribe the 14 space lattices in which points may be distributed regularly in space to Bravais, and designate them as the "Bravais space lattices." Although the 14 space lattices of Bravais embraced the general symmetry of the six crystal systems, still they did by no means account for certain groups of crystals in every system, such as those with hemihedral or hemimorphic symmetry.

Meanwhile J. F. C. Hessel, an obscure crystallographic investigator of Leipzig, studying possible types of symmetry in solids bounded by plane faces, found that 32 such types included all geometrical forms that conform to Haüy's law of rational indices. Thus came into being the theoretical 32 classes of crystal, few of which had been observed in Hessel's time, but many of which he foretold the existence. Although the actual originator of the 32

groups, Hessel remained practically unknown for over 60 years, and the independent work of A. Gadolin, published in St. Petersburg in 1869 duplicated his investigations and carried forward the truth as he sought to propagate it.

Leonhart Sohncke of Leipzig, in 1879 showed how, by substituting for the single points of Bravais space-lattices, groups of similarly oriented points, it was possible to arrange points in space not alone in 14 but 65 typical ways. Most of the point systems of Sohncke are founded on the 14 lattices of Bravais but involve interpenetration of two or more lattices as well as certain movements of translation and rotation. With the 65 point systems of Sohncke much of the symmetry involved in the 32 groups, into which crystals had been divided, was explained in theory; there were however, certain groups of hemimorphic crystals showing dissimilar modifying planes on the two ends of a principal symmetry axis, and enantiomorphous crystals, of which the symmetry relation between corresponding pairs is such that they are described as right-handed and left-handed individuals, both of which categories were unexplainable by any of the point systems of Sohncke.

The culminating step in the coordination of theoretical particle grouping with actual morphological development in crystals was the result of independent discovery by E. von Fedorov, of St. Petersburg. A. Schoenflies, of Leipzig and W. Barlow, of London, who during the years 1890 to 1894 elaborated the Sohncke point systems, by the introduction of the principle of mirror-image symmetry, and added 165 possible particle groupings in space to the 65 previously recognized. All of these 230 point systems conform in symmetry to one of the 32 groups which are themselves exhaustive of all types of crystal development.

The field was now cleared for the last logical sequence in the series of discoveries that linked Haüy's broken calcite crystal to the full knowledge that we now possess regarding the intimate structure of crystallized bodies. Theoretically the chain of reasoning was complete, through the molecular space lattices of Bravais to the atomic point systems of Sohncke, von Fedorov, Schoenflies and Barlow, we knew that these three dimensional patterns must represent the relative positions of atoms in space, but we had no tangible evidence that such groupings of atoms actually existed.

It remained for physical science to shed light upon this problem, and the initial discovery was made in the year 1912 by Dr. von

Laue a physicist of Munich. Special study of the character of the x-rays had led research workers in the field of physics to suspect that the wave length of these vibrations closely approached in their almost infinitely small dimension the distances between successive layers of atoms in a crystal solid. von Laue conceived the idea of using the atomic structure of a crystal (copper vitriol was used in the first experiment) as a diffraction grating for x-rays. By passing a pencil of x-rays *through* a specially oriented crystal plate, von Laue obtained a spectrum diagram consisting of dark spots upon a photographic plate.

The symmetrical disposition of these slightly oval spots constituted a figure conforming to the atomic arrangement presented in the direction of the incident ray. Thus we have at last depicted in terms as it were of the atoms themselves, a plan of the structure erected within the crystal by its constituent atoms, a diffraction pattern. The credit for placing the x-ray investigation of crystal structure upon a *quantitative* basis, with respect to the relative and the actual distances between atoms in three dimensional patterns, is due to Sir William H. Bragg, and his son Professor William L. Bragg, who in 1915 applied to this problem the idea of "reflection" of the x-ray waves from definitely oriented planes traversing the atomic aggregate. In this way x-ray spectra were obtained which furnished data for analyses of crystal structure. As stated by the elder Bragg in the introductory chapter of *X-rays and Crystal Structure*, instead of guessing the internal arrangement of the atoms from the outward form assumed by the crystal, we find ourselves able to measure the actual distances from atom to atom, and to draw a diagram as if we were making a plan of a building. The science of crystallography has emerged into a new era of unrelated observational data as a result of its equipment with a new tool, the x-ray. Research is now being assiduously urged forward in the field of crystal structure in many laboratories on both sides of the Atlantic by physicists and crystallographers using either some form of the x-ray spectrometer, as devised by Sir William H. Bragg, or a still later type of apparatus that employs small amounts of crystallized material in the form of powder, instead of well developed, specially oriented crystals.

Already the literature in reviews under the heading *X-ray and Crystal Structure*, is not only important but exceedingly voluminous, and those of us who can remember back to the "goniometer

pushing" period of research are forceably reminded of the issues of the old *Zeitschrift für Krystallographic* in the 90's when the mathematical crystallography phase of investigation held sway. And incidentally with the passing away of this former era, there has largely vanished from our midst the type of crystallographic draftsman whose beautifully executed work embellished the plates of these old issues of the *Zeitschrift*. I do not say that we are no longer capable of producing such crystal drawings, but I do affirm that we are losing the knack of making them, just as we can no longer manipulate a hand goniometer with the delicacy and skill of our forebears.

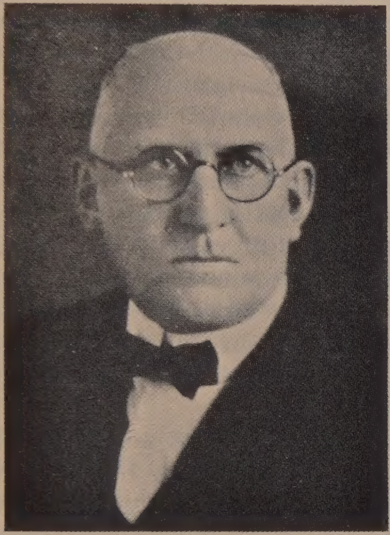
So much for what has happened and is happening in this ancient and honorable science. Now let us indulge ourselves in some speculation as to the character of its next phase of advancement. I venture to predict that the future holds out to us a period, the culminating one, in which the assiduously collected data of mathematical crystallographic research linked with the data now being collected in the crystal structure investigations, will lead to the solving of many far reaching problems to which we have not as yet the keys. To cite only two of these, there is the practically untouched mystery of the relation of crystal habit to crystal genesis, a problem of which I am convinced the answer lies in the study of already collected data, rather than in synthetic laboratory reproduction of conditions. There is also the still unsolved question of the influence of chemical composition on crystal system, a question so intimately bound up with the structure of the atom that it would seem as though we must first solve the physical riddle before we come to the crystallographic one.

But above all, fellow students of crystallography, let us bear in mind that the path to attainment is hard and the rewards are few. Ours must be essentially science for science's sake, and in our devotion to the tasks that lie before us in the years to come, and in our search for truth let us remember those wonderful words of Sir William H. Bragg:— In Science there is no religion, but it is the act of religion.

MEMORIAL OF FRANK ROBERTSON VAN HORN*

EDWARD H. KRAUS, *University of Michigan*.

In the death of Professor Frank R. Van Horn on August 1, 1933, at Cleveland, Ohio, the Mineralogical Society of America lost an enthusiastic and loyal member and an efficient officer, who had been extremely active in promoting the founding of the organization. His loss is great to the Society and to his many friends who had come to know him as one of the stalwarts of American mineralogy.



FRANK ROBERTSON VAN HORN
1872–1933

Frank Robertson Van Horn was born at Johnsonburg, Warren County, New Jersey, on February 7, 1872. He was proud of his Dutch ancestry which he traced to Cornelius Jan van Hoorn, who settled in New Amsterdam in 1640. Professor Van Horn's early training was obtained in the schools of Trenton, New Jersey. In the fall of 1888 he entered Rutgers University, from which he was graduated in 1892 with the degree of Bachelor of Science. During

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the following year he served as an instructor in Mineralogy at Rutgers University and at the same time pursued graduate studies. In 1893 he received the degree of Master of Science. Having at this time definitely decided upon a career in Mineralogy and Geology, he spent the next four years at the University of Heidelberg where he studied with the eminent petrographer, Karl H. F. Rosenbusch, and with the equally distinguished mineralogist and crystallographer, Victor Goldschmidt.

While he was at Heidelberg, the vacation periods were used to visit important geological and mineralogical localities in Central Europe, for purposes of study and collection. Professor Van Horn delighted in relating interesting incidents of these trips. In 1897 he received the degree of Doctor of Philosophy from the University of Heidelberg and in 1919, for distinguished service as a scientist and teacher, his alma mater, Rutgers University, conferred upon him the honorary degree of Doctor of Science.

Since the laboratories of Rosenbusch and Goldschmidt at Heidelberg were largely visited by ambitious young geologists and mineralogists from all over the world, Professor Van Horn was able to develop friendships with many men who afterward became recognized leaders in the earth sciences. He cherished these friendships and sought to deepen them.

At Heidelberg Dr. Van Horn became acquainted with Ezekiel Davidson, then a recent alumnus of the Case School of Applied Science at Cleveland, Ohio, who urged the Case authorities to place him in charge of Geology and Mineralogy. This was done, and in the fall of 1897 Professor Van Horn began his effective career at Case which continued for thirty-six years until the time of his death. He was first appointed as instructor in Geology and Mineralogy, a position he held for two years. In 1899 he was promoted to an assistant professorship and in 1902 he became full professor.

Because of the excellence of the courses he conducted and the well-equipped laboratory he was able to develop, Professor Van Horn was recognized by his colleagues and students as an effective teacher and capable scientist. For many years it was the custom of Professor Van Horn to visit important mining districts in this country with his students. On these trips every effort was made to assemble extensive collections of typical specimens from the various localities. Accordingly, the collections of his department grew rapidly and today the Case School of Applied Science is unusually

equipped with extensive collections of rocks, minerals, and fossils.

Trained in the German methods of identifying rocks and minerals, Professor Van Horn was extremely proficient in the rapid recognition of specimens at sight and in the identification of the localities from which they were obtained. There are few men in America who could equal him in this respect.

At the Case School of Applied Science, Dr. Van Horn was more than a teacher and scientist; he was also the friend and counselor of students and men. His acquaintances among the alumni and student body numbered more than those of any other member of the faculty. This was largely due to the intense interest he took in the athletic and extracurricular activities of the institution. Indeed, he was known as the "father of athletics" at Case. The Van Horn Athletic Field and the Case Club House were made possible because of his untiring efforts and skillful management. They will long bear testimony of the high esteem in which he was held by students and faculty alike. That the students had a deep affection and a high regard for Professor Van Horn is shown by the fact that for many years he was known and addressed as "the Count." This appellation was given to him because of the Van Dyke beard which was so characteristic of him for over a quarter of a century.

In spite of heavy teaching duties and his many extracurricular activities, Professor Van Horn was a frequent contributor to the mineralogical and geological periodicals of this country and Germany. Appended to this memorial is a bibliography of twenty-seven titles.

Professor Van Horn was a member of various national and international scientific organizations, of which only the following will be mentioned: Geological Society of America, of which he was a councilor at the time of his death; American Institute of Mining and Metallurgical Engineers; and the Mineralogical Society of Great Britain and Ireland. He was also a member of several international geological congresses. Indeed, it is thought that the injury he sustained in the summer of 1929, while attending the International Geological Congress in South Africa, contributed indirectly to his untimely death, for he never fully recovered from the effects of that accident. That he was unable, on account of illness, to attend the last International Geological Congress which was held during the past summer in this country, he deeply regretted.

As is well known, and as has already been indicated, Professor Van Horn was one of the founders of the Mineralogical Society of America. At the organization meeting at Harvard University in December, 1919, he was elected a member of the council. For ten years, beginning in 1923, he was the secretary of the Society. Much of the success of our organization has been due to his enthusiasm, loyalty, insight, and efficient management. While his presence at our meetings will be greatly missed, we shall long feel the influence of his forceful and sympathetic personality.

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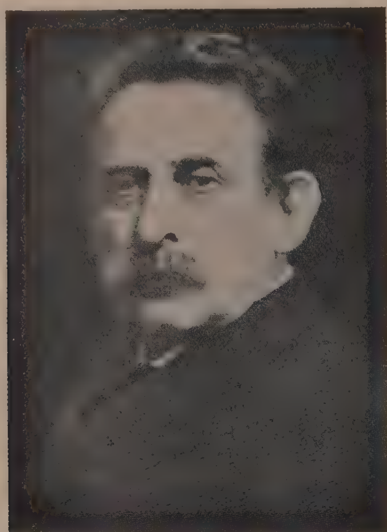
MEMORIAL OF VICTOR GOLDSCHMIDT*

CHARLES PALACHE, *Harvard University.*

Professor Victor Goldschmidt died in Salzburg, Austria, on the 8th of May 1933. In his death our Society loses its most distinguished honorary fellow and many of its members lose a dear friend and revered teacher. His work in crystallography was unique and his place in that field can never be filled.



VICTOR GOLDSCHMIDT
1853–1933

Goldschmidt was born in Mainz, Germany, in 1853 and there he had his early schooling. He entered the Mining Academy at Freiberg, Saxony, as a student of Metallurgy and his first work as a teacher was there, assisting Professor Richter in Assaying and Blowpipe Analysis. He never ceased to be interested in the latter subject, which he taught at Heidelberg long after he had transferred his chief attention to another field. It was, however, the influence of the mineralogist Weisbach at Freiberg that first opened to him the field of his major activity—minerals and their crystal

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forms. In a memoir written after the death of his early teacher, in 1902, Goldschmidt has charmingly pictured the atmosphere of the Mining Academy and the mining town where the spirit of Werner, the founder of the school, still brooded over his creation and Weisbach dwelt as high priest before the door of the holy of holies—the room where Werner's own collection of minerals was preserved. At that time every student was a mineral collector as well as a miner and learned to love minerals as only one can who finds and preserves them himself.

Leaving Freiberg in 1878, Goldschmidt studied chemistry at Munich and with Rosenbusch at Heidelberg became familiar with the then new science of petrography. But it was in Vienna, in the years from 1882 to 1887, that he founded his life work in crystallography. Working alone but under the influence of Brezina of the Hofmuseum, he developed the *Index der Krystallformen*, the solid basis upon which rested the complex structure of his life-long labor.

In 1888 he became a docent at the University of Heidelberg presenting as his habilitation thesis the paper *Ueber Projection und graphische Kristallberechung* already published the year before. Possessed of independent means, Goldschmidt established his own private laboratory where he began to receive students while developing his own plans and studies. In the same year he was married to Leontine von Portheim of Prague, who became in the course of their long and happy life his most active and efficient collaborator. For nearly half a century and to the end of his life Heidelberg remained his dwelling place. In his charming home on the hillside above the city he assembled his unrivalled collection of books on crystallography. And here he and his wife hospitably received the students who from the ends of the earth came to work under his inspiring direction.

Goldschmidt never occupied an ordinary professorship in the University. He always remained an independent teacher, offering talks to the small group which at any one period elected his courses rather than lectures. In the intimate surroundings of his Institute he gave each student the individual help that was needed and was in fact as much companion as instructor. His personal collection of crystals contained abundant material for study which each student carried out with him. And so he joined to himself an ever-widening circle of friends and disciples, who in the course of years carried his methods to the most distant lands.

To few men is it given to envisage so early in a scientific career as clear a picture of what he desired to accomplish as Goldschmidt did. Still fewer succeed in realizing their vision so completely. Goldschmidt's aim was primarily to bring order out of the chaotic mass of crystallographic observations which had accumulated through a century, to reduce them to a common form of expression so that their meaning could be interpreted. First came the *Index der Krystallformen*, a work in which he collected the published data on the crystal forms of all minerals. In the introduction he developed his own system of nomenclature and discussion based on the polar axes, the normals to the pinacoidal body of each crystal. It is interesting to find that the latest tool of crystallographic investigation, the Weissenberg x-ray goniometer, discovers to the investigator the reciprocal lattice which is identical in its nature with Goldschmidt's polarform and polar axes. He also laid particular emphasis on the use of graphical methods and the gnomonic projection.

The three volumes of the *Index* were published in the years from 1887 to 1891. Not discouraged by the vast single-handed labor involved in this organization of the whole literature of mineral crystallography, he passed at once to the next project. His methods proposed that each form on a crystal should be defined by two position angles, comparable to geographical co-ordinates on the sphere, instead of by interfacial angles hitherto universally employed by crystallographers. The adoption of this principle made a complete angle-table for each mineral possible; but the table had to be created from the beginning. In the introduction to his *Krystallographische Winkeltabellen* published in 1897 Goldschmidt gives an outline of his preliminary survey of this undertaking. It showed that something like 33,000 angles and co-ordinates were to be calculated and in all about 70,000 values entered in the tables. This work was completed, with the aid of one calculator, in less than two years.

Meanwhile Goldschmidt, assisted by his mechanic Stöe, designed and constructed instruments suitable for measuring crystals in the new manner. The two-circle goniometer in its present most-used form is the outcome of years of improvement on the first designs.

To complete the cataloguing of the scattered crystallographic data rendered familiar to him by the preparation of the *Index*, Goldschmidt next undertook to collect and reproduce by photogra-

phy all published figures of crystals of minerals. In the *Atlas der Kristallformen* each figure is accompanied by text references showing not only the locality, author and place of publication, but also where the figure is reproduced in other books. Correlation tables for each species make it possible to identify the symbols and letters of various authors in terms of the finally accepted position. This vast labor, begun in 1903, interrupted by the war and by illness, was finally completed in 1923. The first of the nine volumes was issued in 1912; it is very simply dedicated to his wife, without whose vital assistance it is probable that the work would never have been completed. A volume of text accompanies each volume of plates. The plates number 1564, each carrying about 16 figures so that in all about 25,000 figures are reproduced.

The publication of these various works was never permitted to interrupt the steady stream of papers from Goldschmidt's pen in which he made use of the materials thus laboriously made available or added new studies which illustrated his methods of calculation. Growth and solution forms and vicinal planes, "accessorien" as he called them later, were first brought adequately into the range of goniometric study by the development of his new instruments and were used to illumine the form series of minerals. Many papers were devoted to the discussion of the distribution of forms in zones; these investigations had as a major outcome the formulation of his "Law of Complication" and his theory of "Harmony." In the latter a number law derived from crystals is extended to the discussion of serial arrangements as widely diverse as color scales, musical scales and the spacing of the planets in the heavens. These philosophical developments of crystallographic studies, which included a new analysis of musical harmony and a theory of the development in man of the color sense increasingly occupied his interest during his later years. But Goldschmidt's devotion to crystal morphology remained dominant and at the time of his death he was enthusiastically entering a new field of study, seeking to apply to the points of the interference figure of Laue's x-ray photographs the law of complication derived from the study of crystal faces.

In 1916 Professor Goldschmidt and his wife established and endowed the "Josefine und Eduard von Portheim-Stiftung für Wissenschaft und Kunst" as an adjunct to the University of Heidelberg. One branch of this foundation is the "Victor Goldschmidt Institut für Kristallforschung," an institute which will inherit his

library and collections and insure the continuation of his monumental work through the years to come. It is allied to but independent of the University.

Goldschmidt was not willing to lose touch with his students after they left his laboratory. By correspondence and by personal intercourse, as in 1911 when he visited America, he kept himself informed of what they were doing and showed his living interest in their work. His letters, written in a microscopic and marvelously neat hand, are full of the warmest personal feeling.

In 1928 in celebration of his seventy-fifth birthday a handsome *Festschrift* was presented to Goldschmidt by his students. The introduction by Dr. Milch, Goldschmidt's first student, gives an admirable picture of his life and work. Appended is a complete list of his publications, numering 177 up to that time. I present here only the eleven later titles of his most recent papers. Two books containing the gist of the crystallographic work left unfinished at his death are about to appear in print: *Kursus der Kristallometrie*, edited by H. Himmel and K. Müller; and *Betrachtungen zur kristallographischen Systematik* and other studies, edited by M. A. Peacock.

In conclusion I cannot, I think, better illustrate the indomitable spirit of the man of whom I write than to quote in translation his own words written as a conclusion to his Atlas.

> The Atlas der Kristallformen is but a tool for the extension of our great science, Crystallography. And when in the evening of life I contemplate this implement, I do not desire to fold my hands upon my breast. After evening follows night and it is a peculiar joy to labor far into the silent night until the oil in the lamp is burnt out and the light extinguished. Then can one go peacefully to rest.

Goldschmidt's "night" lasted ten years and was as full of activity as any equal period in his life. His illness was short and he went to rest at the age of four score years, possessed of all his faculties and secure in the knowledge that his work is lasting and well done.

Papers by V. Goldschmidt

(*Supplement to list in Goldschmidt Festschrift*)

178. V. Goldschmidt und S. G. Gordon: Crystallographic Tables for the Determination of Minerals. Philadelphia, pp. 1–70, **1928**.

179. T. Gebhardt und V. Goldschmidt: Bestimmung der triklinen Linearelemente aus der gnomonischen Projektion, *Centralbl. für Min.*, A. 1–10, **1930**.

180. V. Goldschmidt: Kristallographische Systematik, *Centralbl. für Min.*, A. 177–190, **1930.**

181.———Autonome und singüläre Knoten, *Centralbl. für Min.*, A. 209–219, **1930.**

182. V. Goldschmidt, Ch. Palache und M. Peacock: Über Calaverit, *N. Jb. Min., Beil.-Bd.* **63,** A. 1–58, 1931.

183. V. Goldschmidt: Binder bei regelmässigen Verwachsungen, *N. Jb. Min., Beil.-Bd.* **64,** A. 27–35, 1931.

184.———Der Planet Pluto und die Harmonie der Sphären, *Akten der v. Portheim-Stiftung*, Nr. **18,** 1–22, 1932.

185.———Die Entstehung unserer Ziffern, *Ibid.*, Nr. **19,** 1–51, 1932.

186.———Unser Alphabet, *Ibid.*, Nr. **20,** 1–164, 1932.

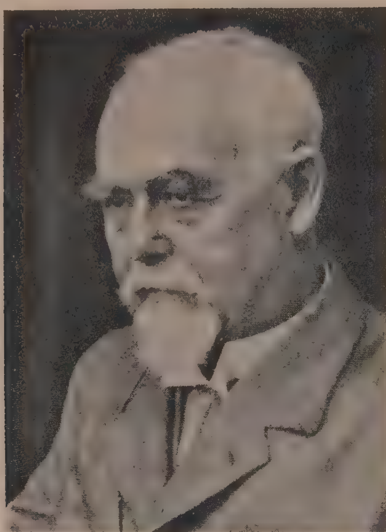
187.———Die Strahlenbüchse für Strahlen-Punktbilder und Reflex-Photographie, *Centralbl. für Min.*, A. 49–52, 1933.

188. V. Goldschmidt und K. Müller: Zwillingsverwachsungen beim Augit. In press.

MEMORIAL OF FRIEDRICH RINNE*

John W. Gruner, *University of Minnesota.*

Friedrich Wilhelm Berthold Rinne, an honorary life member of our society, was born at Osterode in the Harz Mountains on March 16, 1863. It is probable that in the choice of his career he was influenced by his early observations and contacts with minerals and mining in the Harz. He studied under C. Klein at Göttingen and published his first paper on the crystallography of some organic crystals in 1884. When Klein accepted the chair of mineralogy at Berlin in 1887, Rinne accompanied him as his assistant. A part of



Friedrich Rinne
1863–1933

his time was devoted to the assistant curatorship in the Mineralogical Museum of the University. At the age of 31 he was called to Hanover to occupy the chair of mineralogy at the Technische Hochschule. This appointment started his brilliant career. In 1903 he succeeded O. Mügge at Königsberg. From there he was called to Kiel in 1908, and only a year later to Leipzig where he succeeded

* Read at the fourteenth annual meeting of *The Mineralogical Society of America*, Chicago, Illinois, December 28, 1933.

F. Zirkel as director of the Mineralogical Institute. This important post he occupied until the spring of 1928 when he retired to the beautiful little village of Günterstal near Freiburg in the Schwarzwald. The University of Freiburg made him Honorary Professor and a portion of his time was spent at its mineralogical institute. A "Festband" with contributions by his numerous former students had been planned in celebration of his seventieth birthday, but he succumbed to pneumonia on March 12, 1933, four days before.

As a scientist Rinne did not only possess great power of concentration and vision, but had the gift of seeing and inspiring these qualities in those who worked with him. It is not accidental that many of the best known European mineralogists started in his laboratory. His institute, largely due to his administrative genius, was one of the best equipped and most thoroughly supervised in the world. He was the pioneer in x-ray work applied to mineralogy and his book, "Das feinbauliche Wesen der Materie nach dem Vorbilde der Kristalle," passed through several editions.

One of his earlier works, "Gesteinkunde für Techniker," 1901, saw its tenth edition in 1928. It is a classic of its kind. Many of its illustrations were gathered by Rinne on his world tour, especially in Asia from 1899 to 1901.

He published many other notable works especially on zeolites, minerals of Stassfurt, Germany, liquid crystals, and symmetry of the crystal classes. He was one of the foremost leaders who was instrumental in the change from the old style determinative mineralogy to the new science of mineralogy which is really applied physics.

Rinne was a man of meticulous neatness and majesty of manner, yet easily approachable and kind to his subordinates. His genial personality and linguistic ability made him a charming host to the cosmopolitan and international groups which met at his Institute. He could match folksong verses with an Italian, or discuss New York hotels with an Englishman with equal alacrity. His home reflected his travels in the beautiful collections of furniture and works of art. In short, his spirit will live on in those who had the privilege of associating with him.

MEMORIAL OF CHARLES WILFORD COOK*

Walter F. Hunt, *University of Michigan.*

It is with deep regret that we record the passing on February 17, 1933 of Charles Wilford Cook, professor of economic geology at the University of Michigan. His death at the age of 50 years has removed from our midst not only an enthusiastic teacher but also an able investigator as well. Dr. Cook had wide and varied interests as revealed by the scope of his published articles and his affiliations with learned societies. He was one of the charter fellows of the Mineralogical Society of America and also held memberships in

Charles Wilford Cook
1882–1933

the Geological Society of America, the Society of Economic Geologists, the Lake Superior Mining Institute and the American Institute of Mining Engineers. He always took an active interest in the Michigan Academy of Science, Arts and Letters and on one occasion served as Vice-President of the section of geology and mineralogy.

* Read at the fourteenth annual meeting of *The Mineralogical Society of America*, Chicago, Illinois, December 28, 1933.

His rather unusual grasp and understanding of the various phases of geology and closely related subjects was due in no small measure to his early broad training in the fundamental sciences, especially chemistry. Dr. Cook possessed an unusually retentive memory for detailed information that was always at his command. Because of his training he was able to bring into the class room stimulating discussions that were greatly appreciated by the advanced students. Also due to his insight and appreciation of the value of the cognate subjects of geology, such as chemistry, physics, mathematics and mineralogy, he was able to serve and did serve for many years as a wise councilor to students majoring in geology and mineralogy.

Dr. Cook was born in Fenton, Michigan, Sept. 17, 1882, where he received his secondary education and prepared for college. He entered the University of Michigan in 1900 and obtained his A.B. degree four years later and his M.S. in 1906. During this period his special fields of interest were chemistry and mineralogy as revealed by his crystallographic papers on datolite and iodyrite.

In 1906 he accepted the position of Professor of Chemistry at Pacific University in Oregon. However, two years later (1908) he again returned to the University of Michigan serving first as an assistant in mineralogy and in 1909 he received the appointment of Instructor in economic geology. His ability and value to the department were recognized by rapid promotions through the various ranks to that of a full professorship in economic geology in 1925.

As the production of salt is one of the important mineral industries of Michigan it was but natural that Dr. Cook's attention should be drawn to certain problems relating to the occurrence of this mineral. After three years of study his 188 page report entitled "Brine and Salt Deposits of Michigan, their Origin, Distribution and Exploitation" was presented in 1913 as his doctor's thesis. This was printed the following year as Publication 15 of the Michigan Geological Survey.

In order that he might keep in touch with the practical side of his profession Dr. Cook always spent his summer vacations in the field. As assistant geologist of the Michigan Geological Survey (1910–1913) he prepared a number of reports on some of the mineral resources of the state and assisted in the appraisal of mines. Considerable time was also spent in southern and western United States and in Canada, in search for some of the rare minerals, es-

pecially molybdenite. His advice and expert service were frequently sought by interested parties and corporations but he never permitted this outside work to interfere seriously with his University duties.

More recently, with the advent of the discovery of petroleum in Michigan, he found it necessary to spend the greater portion of his time conducting courses in oil geology and in carrying on investigations both in the field and laboratory. The results of these studies are recorded in a number of highly interesting papers dealing with the capillary relationship of oil and water, and on the fractionation and decomposition of petroleum during migration.

Professor Cook's fine personality and cheerful, genial disposition were outstanding personal attributes that gave him a wide circle of friends. That he should have been taken at so early an age is a severe blow to his associates, to the University that he served continuously for nearly a quarter of a century, and to the profession at large.

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MEMORIAL OF LUCIUS LEE HUBBARD*

ALFRED C. LANE, *Tufts College.*

Lucius Lee Hubbard was born at Cincinnati, Ohio, August 7, 1849, the only and also posthumous child of Lucius Virgilius and Annie Elizabeth (Lee) Hubbard. His father, of an old New England family and a Harvard graduate of 1824, was studious, scholarly, and master of several languages.

LUCIUS LEE HUBBARD
1849–1933

As a young man, Dr. Hubbard attended Woodward High School in Cincinnati for three years, Phillip Exeter Academy for two years, and graduated from Harvard in 1872. While there, he was a member of Phi Beta Kappa and several important clubs. His first two years out of college were spent in travelling abroad and in the University of Bonn, studying the German language, history, and international law. He had thought of going into the diplomatic service of the United States, but realized that at that time there was not much chance for "career men". Thus, in March, 1874,

* Presented at the fourteenth annual meeting of *The Mineralogical Society of America,* Chicago, Illinois, December 28, 1933.

he entered the law office of C. T. Russell, in the fall of that year the Boston University Law School, received his LL.B. the following spring, and was admitted to the bar.

On September 29, 1875, he married Frances J. Lambard of Augusta, Maine. From then until 1883, he continued to live in Cambridge with business in Boston, but his legal business interests became overshadowed by others. He was always a collector—of stamps, of Americana, of Robinson Crusoes, of minerals—and in general was a lover of the great outdoors which took form in his first book (1877), "Summer Vacations at Moosehead Lake and Vicinity." This was gradually expanded under other titles and he celebrated the fiftieth anniversary of the map by revising the thirteenth edition.

His interest in the rocks, and especially the porphyries of Mt. Katahdin, led him back to Europe in 1883 to again study mineralogy, geology, and chemistry, in Bonn under Von Lasaulx, where he took his A.M. and Ph.D. in 1886 with a mineralogical thesis—"Briträge zur Kenntnisse der Nosean-Führenden Auswürflinge des Laacher Sees" published in Tschermak's Mineralogisch-petrographischen Mitteilungen, volume 8, part 5.

In November 1886, he went to Heidelberg and worked several months under Rosenbusch, among other things, devising a method of testing the specific gravity of minute grains by gauging their fall in an upcurrent of water. In 1887 he travelled and collected in Switzerland and Italy, returning to his Maine woods for the summer and oscillating between them and Boston until 1890 when he received an offer to join the staff of the Michigan Geological Survey and the School of Mines.

Dr. Hubbard's business and legal training, and command of executive and diplomatic language was of service not only to him but to his associates both in the Geological Survey and other positions which he came to fill. There are many records of this. Thus, M. E. Wadsworth, the head of the Geological Survey, who often in scientific controversies used language which offended more than he expected, once pencilled to Dr. Hubbard, "Please to see when I criticize work of others that the language is put in the best and least offensive form." Later, as a Regent of the University of Michigan, it was to Dr. Hubbard that the task of pacifying wrathy alumni sometimes fell, and it was usually done without much retraction.

Although partially color-blind, Dr. Hubbard's keenness of sight and his discrimination of lusters and of colors as he *did* see them enabled him not only to be a great philatelist and a safe gatherer of mushrooms, but a first class mineral collector, to the great ultimate advantage of the Michigan College of Mines.

When the close relations of the Geological Survey and the College of Mines was terminated in 1893, Dr. Hubbard became State Geologist until 1899 when, dissatisfied with the State's provision for the Survey and his own work hampered, he resigned. He was then employed by various concerns and within a year had located the Champion Mine. Others followed and at the same time, he continued without salary to aid Dr. A. C. Lane who succeeded him as head of the Survey.

Gradually, as he grew older and relinquished his business cares to younger men, his life-long interest in collecting and literature grew, but he also retained his interest in public and civic affairs for which his experience and training had well fitted him. Thus he was appointed a member of the Board of Control of the Michigan College of Mines in 1905 and remained upon it until 1917. He was also appointed to the Board of Regents of the University of Michigan in 1910, was elected in 1911, and reelected continuously, resigning from failing health in the year of his decease.

His later interests in literature were doubtless stimulated by his association with these educational institutions. By 1917, his collection of Americana became too much to house in his fireproof library —"as complete and important a one as was ever privately made (up to that time)"—and was sold, like his earlier stamp collection. His mineral collection he gave to the Michigan College of Mines. Of late years, he concentrated on his collection and studies of the sources and editions of Robinson Crusoe and in studying the history of the early editions of Gulliver's Travels, in which he showed that genius for minutiae which was a strong characteristic. His studies of his books were of scholarly value, the result of earnest research and were not merely interesting notes. It is probably due to these changes in his interests that he is not better known to the younger mineralogists and geologists, but his interest in these phases remained to the end. This collection of early editions he gave to the University of Michigan.

His wife preceded him in death by several years, but not until they had been able to celebrate their fiftieth wedding anniversary.

Dr. Hubbard's bibliography is as varied as were his interests. In it there are fourteen papers and reports dealing with phases of mineralogy and geology, eight on topics related to his studies of his library of Americana, Robinson Crusoe and Gulliver's Travels, philately, and legal codification. It is probable there are others which have been missed.

Quiet and unassuming, but doing much good when and where least expected, as many of his beneficiaries would quickly affirm, Dr. Hubbard, always studious and active (his last published contribution, a note on Colombian stamps, appeared only four months before his death), spent much of his later years between Florida in winter[1] and the Keweenaw Peninsula in summer. Here he died at Eagle Harbor, August 3, 1933, in the country in which the development of whose mineral resources he had done so much to guide and aid.

[1] Where he collected hundreds of specimens of *Strombus pugilis*, and classified the variations for the Museum of the University of Michigan.

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA AT CHICAGO, ILLINOIS

Albert B. Peck, *Acting Secretary*.

The Mineralogical Society of America assembled on December 28 and 29, 1933, for its fourteenth annual meeting in conjunction with the Geological Society of America, at Chicago, Illinois, as guests of the University of Chicago.

The first meeting of the Society was called to order on Thursday, December 28, at 2:15 P.M. in room 202 Eckhart Hall, by Prof. A. N. Winchell, acting as Chairman at the request of the Council, in the absence of the President, Dr. H. P. Whitlock, who was unable to be present.

Prof. Winchell announced that the reading of the minutes of the last meeting would be dispensed with since they had been printed on pages 106–120 of volume 18 of *The American Mineralogist*.

ELECTION OF OFFICERS AND FELLOWS FOR 1934

The Secretary announced that 126 ballots had been cast unanimously for the officers as nominated by the Council. For Fellows a unanimous vote of 62 ballots was cast in the affirmative. All officers and fellows were declared elected.

The Officers elected for 1934 follow:

President: John E. Wolff, Pasadena, California

Vice-President: W. A. Tarr, University of Missouri, Columbia, Missouri

Secretary: Paul F. Kerr, Columbia University, New York City

Treasurer: Waldemar T. Schaller, U. S. Geological Survey, Washington, D. C.

Editor: Walter F. Hunt, University of Michigan, Ann Arbor, Michigan

Councilor for 1934–1937: Edward P. Henderson, U. S. National Museum, Washington, D. C.

The Fellows elected follow:

Dr. William M. Agar, Department of Geology and Mineralogy, Columbia University.

Dr. Tom. F. W. Barth, Geophysical Laboratory, Washington, D. C.

Dr. D. Jerome Fisher, Department of Geology and Mineralogy, University of Chicago.

Forest A. Gonyer, Department of Mineralogy, Harvard University.

A. H. Koschman, U. S. Geological Survey, Washington, D. C.

Dr. Phillip Krieger, Department of Geology and Mineralogy, Columbia University.

Dr. G. F. Loughlin, U. S. Geological Survey, Washington, D. C.

Dr. Hugh F. McKinstry, Hollinger Gold Mines, Timmins, Ontario.

Dr. James E. Maynard, Department of Geology and Mineralogy, Syracuse University.

Dr. Adolph Pabst, Department of Geology and Mineralogy, University of California.

Dr. Martin A. Peacock, Department of Mineralogy, Harvard University.

REPORT OF THE SECRETARY FOR 1933

To the Council and Members of the Mineralogical Society of America:

The Acting Secretary herewith begs to report that the roll of the Society now consists of 115 Fellows and 280 Members in good standing, a loss of two from last year. Five Fellows, C. W. Cook, F. Rinne, V. Goldschmidt, F. R. Van Horn, L. L. Hubbard, and one Member, W. L. McLaren, are known to have been lost through death during the year; the chief loss, from the standpoint of the Society as a whole, was that of our able and enthusiastic Secretary for the past eleven years. There are at present 257 subscribers to the Journal.

Additions				
	Fellows	5		
	Members	40		
	Subscribers	31	76	
Losses				
	Fellows	5		
	Members and subscribers	58	63	
Net gain				13

A total of about 660 paid copies of *The American Mineralogist* is mailed monthly, which is a gain of about 10 over last year, a not inconsiderable increase in the face of prevailing conditions.

Your Acting Secretary can not refrain from pointing out at this time his belief that no small part of this gain and the good order of the rolls of the Society are due to the efforts given by our late Secretary, as well as those of our Treasurer.

Respectfully submitted,

ALBERT B. PECK, *Acting Secretary*

On motion the report of the Secretary was accepted and ordered filed.

REPORT OF THE TREASURER FOR 1933

To the Council of the Mineralogical Society of America: Your Treasurer submits herewith his annual report for the year beginning December 1, 1932, and ending November 30, 1933.

RECEIPTS

Cash on hand December 1, 1932	\$1,355.49	
Dues and subscriptions	2,108.02	
Advertisements	343.02	
Sale of back numbers	134.20	
Interest on endowment	2,517.75	
Bank interest	6.92	
Authors' refund on separates	28.84	
		\$6,494.24

DISBURSEMENTS

Printing and distribution of the Journal (12 issues)	$3,372.92	
Printing and distribution of separates	311.59	
To the Editor, Secretary and Treasurer	720.00	
Postage	80.63	
Printing and stationery	57.19	
Refunds on dues	47.00	
Checks returned	28.50	
Bank collecting charges	3.65	
Check tax	1.26	
Safety deposit box	8.25	
Clerical help	43.07	
Bond coupons returned	55.00	
Telegram	0.76	
Committee expenses	10.79	
Roebling Medal fund (Reserved in bank account of Society)	100.00	
	$4,840.61	
Cash balance November 30, 1933	1,653.63	
		$6,494.24

The endowment funds of the Society as of November 30, 1933, are the same as a year ago, and consist of:

45	$1,000 bonds of the City and County of Honolulu, Water Works, 5%, due 1954	$45,000.00
4	Liberty bonds, $100 each, 4th, $4\frac{1}{4}$%, due 1933–1938	400.00
4	$100 bonds, Great Northern R. R., $5\frac{1}{2}$%, due 1952	400.00
2	$1,000 bonds, Trenton Mort. and Title Guar. Co., $5\frac{1}{2}$%, due 1937.	2,000.00
2	$1,000 bonds, Trenton Mort. and Title Guar. Co., $5\frac{1}{2}$%, due 1938.	2,000.00
1	$1,000 bond, Denver Gas and Electric Light Co., 5%, due 1951	1,000.00
		$50,800.00

Respectfully submitted,
W. T. SCHALLER, *Treasurer*

It was moved that the Treasurer's Report be accepted and filed.

The Secretary then read the report of the Auditing Committee which consisted of three non-members of the Council and which had been appointed by President Whitlock early in December. The report follows:

Washington, D. C.
December 11, 1933

To the President of the Mineralogical Society of America:

The Auditing Committee has examined and verified the accounts and report of the Treasurer for the fiscal year ending November 30, 1933. The Committee also certifies that the securities listed in the Treasurer's report are in the safety deposit box in the vaults of the American Security and Trust Company of Washington, D. C. All future coupons are intact and are attached to these securities with the following exceptions: Four bonds of the Trenton Mortgage and Title Guaranty Company of a total par value of $4,000, have been changed to registered bonds (registered both for principal and interest) and the coupons detached and destroyed.

OLIVER BOWLES, *Chairman*
LOUIS W. CURRIER, H. E. MERWIN,

REPORT OF THE EDITOR FOR 1933

To the Council, Fellows and Members of The Mineralogical Society of America:

In times like the present the duties of the Editor are not confined exclusively to the evaluation and proper selection of manuscripts submitted for publication in *The American Mineralogist*, but includes as well the still more difficult task of stretching the limited income so as to obtain therefrom the largest possible returns. In recent months the number of desirable papers that have been accepted has increased steadily. The income, on the other hand, has not kept pace with the demands made upon the Journal. The task therefore has become an extremely trying one, especially this past year, and articles have not appeared quite as promptly as in the past due to the congestion.

It should be kept in mind, also, that an allowance of $300 for a monthly issue of 1000 copies does not permit the impossible and explains why it is absolutely necessary at times to obtain from authors or institutions financial assistance when the length of a contribution or, more particularly, when the excessive number of illustrations would increase the cost of the paper beyond permissible limits.

These facts are brought to your attention not for the purpose of discouraging the submission of contributions but rather to bring before you certain pertinent facts relating to the financial side of the editorial work which at times enthusiastic contributors are quite likely to overlook. In this connection may I suggest, therefore, that authors keep the number of illustrations within reasonable bounds or be willing to assist in defraying the cost if the number is excessive. The policy of inviting contributions from everyone has not been changed but naturally members and fellows who are loyally supporting the Society are given preference.

A cursory examination of the Journal for the current year will reveal a normal volume of 550 pages, consisting of 12 regular issues of fairly uniform size and averaging approximately 48 pages each. No opportunity was presented this past year for the issuance of an unusually large and attractive special number, but it is hoped that when conditions become more normal this feature will again become a reality from time to time.

Among the noteworthy accomplishments for the year mention might be made of the publication of the Directory of American and Canadian Mineral Collections. The data for these 700 public and private collections, representing the most recent and authentic information obtainable, was collected by Mr. Samuel G. Gordon and made available to our readers in installments running through five successive issues of the Journal. A limited number of reprints of this Directory containing the assembled installments will soon be available and will be sold at 50¢ each as long as the supply lasts.

In briefly summarizing some of the major points of interest in volume 18 it will be noted that approximately 74% of the entire space of the Journal was devoted to 51 leading articles. In addition 17 shorter papers have appeared under the division of Notes and News thus increasing the total number of published manuscripts to 68. These contributions were received from 74 individuals representing no less than 38 different Universities, research bureaus and technical laboratories. It is also gratifying to record that the list of published articles includes four foreign contributions—two from Canada and one each from Belgium and Japan.

A survey of the titles of papers that have appeared in the current volume will

reveal the usual wide range of subject matter that has characterized the Journal in recent years. While it is impossible to classify all articles accurately as frequently contributions overlap divisional lines, nevertheless it may be of some interest to attempt a general classification of the 51 main contributions. Fifteen articles have been classified as belonging to the division of descriptive mineralogy; eight to chemical mineralogy; seven have stressed optical data; ten have been assigned to structural and five to geometrical crystallography; while petrography, addresses and papers of a miscellaneous character are represented by six contributions. Included in the list are the detailed descriptions of five new minerals—corvusite, rilandite, tilleyite, ammonioborite and colusite.

Also as in the past considerable space has been devoted to book reviews, abstracts of new mineral names, news items and the proceedings of various mineralogical clubs and societies.

As regards the year to come every effort will again be made to issue a volume as large as possible and still keep the expenditures within the assured income. No marked expansion, if any, seems likely from present indications. Also if it is found impossible to cover the entire fields of "mineralogy, crystallography and the allied sciences" it may become necessary in the future to reject certain border-line papers and articles of a non-mineralogical character.

The concluding table of contents summarizes the distribution of subject matter in volume 18.

Distribution of Subject Matter in Volume 18

Subjects		*Articles*	*Pages*	*Per cent of Total*
Leading articles				
Descriptive mineralogy	15			
Chemical mineralogy	8			
Optical mineralogy	7			
Structural crystallography and mineralography	10			
Geometrical crystallography	5			
Petrography, memorials, etc.	6			
		51	409½	74.2
Proceedings of societies		25	44½	
Notes and news; Short articles		38	86	25.8
Abstracts of new mineral names		17	6½	
Book reviews		7	5½	
Total of text		138	552	100.0
Illustrations		118		
Covers, advertisements, index			114	
Total			666	

Respectfully submitted,
Walter F. Hunt, *Editor.*

REPORT OF THE COMMITTEE ON NOMENCLATURE AND CLASSIFICATION OF MINERALS

The Chairman, W. T. Schaller, reported that substantial progress had been made in bringing about agreement with the British Committee as a result of a joint session held with that committee during the meetings of the XVI International Geological Congress last summer; that there were very few points not yet agreed upon; and that as a result of this, the outlook for international agreement was much more hopeful.

It was moved that the committee be continued.

There were no reports from the Representative on the National Research Council or from the Committee on Co-operation with the Secretary of the XVI International Geological Congress along the Lines of Mineralogy and Petrology.

REPORT OF THE COMMITTEE ON THE WASHINGTON A. ROEBLING MEDAL

The Chairman, E. H. Kraus, reported that \$100 had already been set aside for use of the Committee and that after \$300 had been accumulated, awarding of medals could be initiated.

NEW BUSINESS

There being no new business, H. Berman announced that photostatic copies of crystallographic angle tables of 95 minerals, prepared at Harvard University to supplement those of Goldschmidt, were available at a price of \$2.00. Other tables are expected to be available in the future.

The Secretary announced that the annual luncheon of the Society would be held at the Quadrangle Club, on Friday, December 29, at 12:30 P.M.

MEMORIAL BIOGRAPHIES

Memorial biographies of the five Fellows who have died during the year 1933 were then read as follows:

C. W. Cook (died Feb. 17, 1933) by W. F. Hunt

Friedrich Rinne (died Mar. 12, 1933) by J. W. Gruner

Victor Goldschmidt (died May 8, 1933) by C. Palache

F. R. Van Horn (died Aug. 1, 1933) by E. H. Kraus

L. L. Hubbard (died Aug. 3, 1933) by A. C. Lane

With the conclusion of the reading of the biography of Prof. Van Horn, at Dr. Schaller's suggestion the audience rose and stood in silence for a moment in tribute to the memory of the late Secretary.

PRESENTATION OF PAPERS

There being no further business, at 3:30 P.M. the Society proceeded to the reading of scientific papers. Short abstracts of the papers presented follow:

T. L. WALKER: *The Royal Ontario Museum of Mineralogy.* (a) Exhibition by slides of the general plan of the building and especially of the part devoted to Mineralogy. (b) An account of some new types of museum display suited to mineralogy. (c) The policy of the museum for its extension by collecting from its home field with a view to exchange with other institutions.

Charles Palache: *Contributions to Crystallography: (a) claudeite; (b) minasragrite; (c) samsonite; (d) native selenium; (e) indium.*

(a) Claudeite is described from two new localities in California and Arizona, and on the basis of excellent crystal measurements, a new axial ratio and an angle table are calculated.

(b) Minasragrite crystals from the original vanadium deposit in Peru are described for the first time, and their monoclinic nature is established and an angle table is calculated.

(c) Samsonite crystals from Andreasberg, the only known locality, are described, new measurements are given, and two new forms established. Previous observations are summarized, and a new axial ratio and angle table calculated from mean values of all observations are presented.

(d) The paper presents the first measurements of natural crystals of selenium and the first actual determination of its unit form. It is rhombohedral but not isomorphous with tellurium.

(e) The crystal form of indium, determined on artificial crystals, is tetragonal.

Charles Palache: *Crystallography of the Uranium Oxides.* This paper presents a summary of published descriptions of the crystallography of the minerals schoepite, becquerelite, "mineral X," fourmarierite, inathinite, and curite, together with some newly observed data. Elements and angle tables are given for each of them, the choice of position in each case being selected in order to bring into harmony their form relations and analogous cleavages and optical properties. Schoepite, concerning which our knowledge is most complete, is made the basis of the comparison. The elements of becquerelite, fourmarierite and ianthinite are transformed from the positions originally chosen for them. The inadequate chemical data for most of the species and the lack of structure studies makes it impossible as yet to explain satisfactorily the form relations of the series.

Charles Palache: *Pseudobrookite.* A summary of existing data on the crystallography of pseudobrookite is presented. Combining with these data new observations made on the mineral from a new occurrence in Utah, a new unit form and axial elements are chosen and an angle table is calculated.

A. L. Parsons: *An Unusual Calcite Crystal from Godfrey, Ontario.* A description of a large crystal showing as its dominant form the second order pyramid ($80\bar{8}1$) (Gdt) and a rough terminal second order pyramid ($10\bar{1}1$) (Gdt).

A. L. Parsons: *A Simple and Inexpensive Projection Sheet for Gnomonic and Stereographic Projections.* Description with costs of a projection sheet for projecting ϕ, tan ρ, and tan $\rho/2$.

Austin F. Rogers: *Zones as the Basis for the Definition of Crystal Systems.* For other than elementary work axes of reference for defining the crystal systems are not sufficiently accurate. Examples are cited where this is true. A classification into systems based upon four types of zones—hexagonal, tetragonal, orthogonal, and clinogonal—is suggested, which combines simplicity with accuracy. In addition, zone-bundles are used, a zone-bundle being defined as a complex of zones with one face in common. It is further shown that upon this basis only six distinct systems are possible.

R. C. Emmons and E. F. Williams: *A High Index Refractometer.* A crystal of smithsonite is mounted in a hole in a microscope slide in such a way that a small amount of index liquid may be placed around it. The grain is then placed on the universal stage and simply oriented. Rotation from the oriented position in the principal section changes the index of transmitted light until the crystal and liquid agree. A curve gives the index for visible wave lengths of light. The standard universal stage water cell gives temperature control. Indices may be read as high as 1.86.

Theodore A. Dodge: *Determination of Optic Angle with the Universal Stage.* In 1923 Berek described a procedure to be used with the Leitz universal stage for the determination of the orientation of the optic elements and the size of the optic angle of biaxial minerals in thin section. With the increased use of immersion methods and the introduction of the Emmons universal stage, need has arisen for a more flexible method of determination, the presentation of which is the aim of this paper. Sets of curves in place of the single curve of Berek make the determinations much more simple and give them a wider range of accuracy. The new method is adapted to form an integral part of any universal stage procedure whatever, providing the crystal is to be completely oriented, and is for use with either the Leitz or the Emmons instruments in either thin section or immersion work.

J. D. H. Donney, G. Tunell, and T. F. W. Barth: *The Various Modes of Attack in Crystallographic Investigation.* The methods of describing crystals found to be most suitable for determinative purposes are not necessarily identical with those aiming at morphological characterization or structural determination. This conclusion has previously received little emphasis, but it need not occasion surprise since the development of an investigative tool is naturally governed by the purpose for which it is intended, and the aims of these three methods are quite distinct. The principal methods in these various lines of attack are reviewed.

The determinative procedure stands entirely apart from the other two and in it some arbitrariness is permitted if it facilitates the attainment of its limited goal.

The experimental basis for morphological investigation is the surface whereas the structural starting point is the interior of the crystal. Admittedly the results of these two methods should agree, but so far their exact relationship is unknown. Hence neither can be discarded in favor of the other under penalty of leaving experimental facts unexpressed, the knowledge of which can be expected to contribute to the elucidation of the relationship in question.

R. C. Emmons: *Plagioclase Determination by the Modified Universal Stage.* A procedure is recommended, which, in principle is similar to the original procedure of Fedorov, but is facilitated and considerably speeded by the use of the universal stage with five axes of rotation. The procedure leads also to the determination of the feldspar twin laws. An outstanding advantage of the universal stage method lies in the ability to determine almost any plagioclase feldspar grain chosen in a thin section, without searching for one of favorable orientation.

John W. Gruner: *Relation of Silicate Sheet Structures—a Demonstration with models.* The sheet structures of the micas, brittle micas, chlorites, pyrophyllite, vermiculites, and kaolinites are closely related. They may be thought of as com-

binations of layers of the composition $(Si, Al)_4 O_{10}$ and $(Al, Mg, Fe)_{2\text{-}3}OH_6$ arranged in different orders. With the aid of a few models of these sheets all these structures can easily be built and discussed.

The Society adjourned at 5:30 P.M. to convene at 9 A.M., Friday, December 29.

* * * *

Prof. T. L. Walker called the second session to order at 9:15 A.M. on Friday, December 29, and the reading of papers continued.

G. Tunell and C. J. Ksanda: *The Relation of x-ray Goniometer Data to Reflection Goniometer Measurements on Sylvanite.* A crystal of sylvanite from Cripple Creek, Colorado, was studied by means of the Weissenberg x-ray goniometer. Rotation and Weissenberg photographs of the equator and first and second layer-lines made possible a rigorous determination of the appropriate unit cell; also the space lattice, and the twin law. The systematic extinctions on the Weissenberg films of sylvanite limit the space-groups possible for it to two space-groups the extinctions of which are identical. The same crystal was measured on a Goldschmidt reflection goniometer and the measurements and observations with it complete the determination of the space group and confirm the twin law.

C. S. Hurlburt, Jr., and F. A. Gonyer: *A New Group of Phosphates.* From the pegmatitic knots in the granite near Hillside, Arizona, comes new a group of phosphates. The principal mineral is found in four separated localities within a radius of ten miles. This mineral is a salt of the acid, $H_8P_2O_9$ hitherto not found in nature. At one locality this principal mineral has been altered to produce seven others. The optical properties of all the minerals are given, together with the chemical analyses and crystal descriptions of some of them.

W. A. Tarr: *A Study of the Linnaeite Group of Sulphides.* The linnaeite group of cobalt-nickel-copper-iron sulphides includes several minerals—linnaeite, siegenite, carrollite, sychnodymite, polydymite, and beyrichite—to which the general formula R_3S_4 or $RS.R_2''S_3$ (R=Co, Ni, Fe, Cu and R''=Co, Ni, Fe, Cu and R'''=Co, Ni, Fe) has been given. A study of the best analyses available was made and the most probable formula was deduced. Other relationships were pointed out.

Charles Palache: *Minerals from Topaz Mountain, Utah.* This is an account of the new collections from the well-known locality which added to the paragenetic series of minerals the four species pseudobrookite, beryl, fluorite, and calcite. The pseudobrooklite yielded crystallographic data leading to a new axial ratio for this rare mineral.

Chester B. Slawson: *Sussexite from Iron County, Michigan.* Prior to 1929 no borates had been recognized as associates of the ores of the iron ranges of the Lake Superior District. Since that date seamanite and magnesio-sussexite, both new species, have been reported from northern Michigan. Sussexite is shown to be closely associated with seamanite. A study of the minerals of this area may reveal other minerals of this type and give further evidence of hydrothermal activity in this area as has been suggested by Gruner.

Kenneth K. Landes: *The Beryl-Molybdenite Deposit of Chaffee County, Colorado.* The deposit consists of a quartz vein containing beryl, molybdenite, and minor amounts of sericite, tourmaline, and secondary molybdite. It is located at the headwaters of Brown's Creek, a tributary of the Arkansas River which drains the south slope of Mt. Antero. The property was worked about 15 years ago and is known as the California mine. Two generations of quartz are present. Molybdenite was the last primary mineral to be deposited. In its general occurrence molybdenite is a fairly persistent mineral, but beryl is rarely found outside of pegmatites. It is suggested that the Chaffee County deposit represents a link between pegmatites and quartz veins.

Carl R. Swartzlow: *Two Dimensional Dendrites and their Origin.* Two dimensional dendrites are those that have considerable length and breadth but whose thickness is negligible. Dendrites were grown in the laboratory under simulated natural conditions, both with compounds common in nature and with compounds not reported in the literature as composing dendrites. The most successful experimental dendrites were produced between joint planes and by the effect of surface tension upon evaporating liquids.

Lloyd W. Fisher: *Growth of Stalactites.* Stalactites growing in a concrete archway under the Gulf Island Dam, near Lewiston, Maine, have been measured at intervals over a period of two years and rates of growth have been established. These rates of growth are compared with those noted by observers in other localities and under different conditions. Comparisons were also made between stalactites on the up- and down-stream sides of the arch. Conditions of temperature and pressure within the tunnel are considered.

J. F. Schairer and N. L. Bowen: *Preliminary Report on the System,* K_2O—Al_2O_3—SiO_2. Three ternary compounds have been found in this system—orthoclase, leucite, and kaliophilite. Orthoclase melts incongruently with the formation of leucite. The fields of stability of cristobalite, tridymite, quartz, mullite, corundum, leucite, orthoclase, kaliophilite, and potassium disilicate have been delineated.

A. P. Beavan and J. F. Hawley: *Mineralogy and Genesis of the Mayville Iron Ore of Wisconsin.* (Read by Title.) Study of the Mayville oolitic iron ore by chemical, microscopic, and *x*-ray methods reveals a large number of minerals. The oolites consist of concentric shells of these minerals commonly deposited around nuclei of fossil, mineral or oolitic fragments. Nearly all the phosphorus of the ore (approximately 1.5%) is contained in the oolites, where it is distributed in the harder outermost layers and in some of the softer spheroids within. Chemically, phosphorus is combined with iron, aluminum, and calcium. The matrix is composed essentially of goethite and hematite. Evidence is cited to support four conceptions regarding the genesis of the ore.

H. N. Fisk (Introduced by Chas. H. Behre, Jr.): *The Significance of Three Generations of Plagioclase in an Andesite-basalt Flow.* A systematic study was made of oriented thin sections from samples collected at three foot intervals throughout a 150 foot porphyritic andesite-basalt flow from Rogue River Valley, Southwestern Oregon. The evidence of intratelluric and of two later stages of plagioclase and the

criteria for the recognition of these three stages are presented. The type and mineral associations illustrate fractional crystallization, reaction between the solids and fluid to effect, by successive stages, an enrichment of the residual liquid in iron, sodium, and silicon oxides, and an impoverishment of the liquid in calcium, magnesium, and aluminum oxides. The evidence upon which these generalizations rests is chiefly petrographic.

Duncan Stewart, Jr.: *The Petrography of the Beacon Sandstone of South Victoria Land.* Fifty-two specimens of sedimentary rocks from the Beacon sandstone formation of South Victoria Land, Antarctica, collected by the Byrd, National Antarctic, and Terra Nova expeditions have been examined qualitatively and quantitatively with the petrographic microscope, and two analyses have been added to those previously recorded. Arkoses are noted in Mount Fridtjof Nansen, Queen Maude Mountains, which extends the known occurrence of the type many miles to the eastward of the Beardmore Glacier area studied by the British. The derivation of the mineral constituents and the conditions under which deposition took place varied considerably.

Lincoln Dryden (Introduced by E. B. Mathews): *Statistical Correlation of Heavy Mineral Suites.* Several recent improvements in the technique and theory of heavy mineral analysis make possible an increased accuracy of work. The percentages obtained can be accepted with confidence and can be used in correlation of samples. Correlation by heavy minerals has heretofore remained a matter of personal opinion. Two sets of data can be correlated statistically by well known formulae. A coefficient of correlation between any two sets can be transformed into the "coefficient of determination." By the use of the different values of this coefficient "correlation by heavy minerals" is given a numerical value expressing the percentage of elements common to the sets.

A. E. Alexander: *Some Interesting Heavy Minerals from the Sediments Collected on the Continental Shelf off Northeastern United States.* As a result of the study of several hundred samples from the continental shelf from Cape Cod to Maryland, thirty-six heavy minerals were identified. Correlation of these from north to south showed several important differences. However, since the crystalline areas of New England, New York, New Jersey, and Maryland, are generally somewhat similar, it is to be expected that the mineralogy of the shelf samples from these various stations would be in general similar. Only a few minerals could be classed as diagnostic. Andalusite and weakly pleochroic hypersthene are most characteristic of the northern lines, while on the New Jersey and Maryland lines, a salmon colored garnet and strongly pleochroic hypersthene are very diagnostic. The best graded profiles were found to exist off Cape Cod, the grade sizes here corresponding most closely with the bottom profiles where equilibrium had been most nearly established. Evidence of this is given by the average grade sizes as taken from the Nauset Cape Cod line.

J. J. Runner: *The Association of Certain Igneous and Sedimentary Amphibolites.* Several workers in the Black Hills pre-Cambrian rocks have noted a remarkable coincidence in occurrence of amphibolites derived from basic intrusives with others derived from impure carbonate rocks. Recent studies in this region have revealed further examples of this phenomenon, together with a close association of these

rocks with ferruginous quartz veins. There are many thousands of feet of pre-Cambrian in which igneous amphibolite and quartz veins are lacking, but much of the greatest development of the basic intrusives is in the horizons of calcareous rocks. Various explanations for this association are suggested with the emphasis laid upon the possible effect of calcareous beds in localizing the intrusives by causing their precipitation. The silica of the accompanying quartz veins is believed to be derived from the igneous rocks at the time of consolidation.

D. Jerome Fisher: *Coal Composition*. Each of the layers in banded coal belongs to a rock series; i.e., each is in general microscopically heterogeneous and varies fairly regularly as traced through the different ranks. The organic constitution of each of these may be described in terms of microscopically homogeneous units, tentatively regarded as organic mineral series, as indicated in the table.

Popular Terms	Terms for Coal Petrographers		
	Rock Series Terms	Mineral Series Terms[1]	
		Essential	Accessory
Bright Coal	Vitrain	Vitrite[2]	Resins, Fusite, etc.
	Clarain	Vitrite Cuticular matter Exine material[3]	Fusite Resins Durite minor[4]
Dull Coal	Durain	Durite	Exine material Cuticular matter Algal material Fusite Resins Vitrite
Coal Charcoal	Fusain	Fusite	Resins rare (Inorganic Minerals)

[1] These terms represent series; species may be designated as semi-bituminous durite, anthracite fusite (metafusite), etc.

[2] To be Germanized as "vitreit."

[3] All three of these are not essential in all clarains.

[4] Use duro-clarain or claro-durain where percentages of durite are 5 to 10 and 10 to 25 respectively. Similarly use claro-vitrain or vitro-clarain (if less than 5 per cent durite) where percentages of vitrite are 90 to 95 and 75 to 90 respectively.

Each of the translucent organic mineral series units in the bituminous ranks appears anisotropic in polarized light; the vitrite is uniaxial (probably a strain phenomenon) with optic axis perpendicular to the bedding, contrasting with the undulatory extinction shown by exines and algal remains. Specimens studied to date show

low birefringence and n ranging from 1.76 for low rank bituminous vitrite to 1.87 in semi-bituminous vitrite. Further studies of vitrite are in progress.

Clayton G. Ball (Introduced by Ralph L. Grim): *Kaolinite in Illinois Coal* Petrographic investigations of mineral matter in Illinois coals show that kaolinite is a prominent mineral constituent. It habitually occurs in the narrow, vertical shrinkage cracks common in bands of vitrain (anthraxylon) and in the cellular cavities characteristic of fusain. The optical data, x-ray diffraction patterns, chemical analyses, and dehydration curves on which identification is based, are presented. Since the presence of kaolinite in coal is not widely expressed in the discussion of the composition of coal and its ash-forming constituents, this information is considered important.

At 11:55 A.M. a recess was taken for the annual luncheon, which was held at the Quadrangle Club and at which 45 persons were present.

* * * *

Prof. A. H. Phillips called the third session to order at 2:15 P.M. for the conclusion of the reading of papers.

Edward H. Watson (introduced by W. T. Schaller): *Differentiation in Teschenite Sills at El Mulato, Mexico.* A series of teschenite sills with a maximum thickness of 50 feet occur near the village of El Mulato, State of Tamaulipas, Mexico. They are accompanied by dikes of olivine monchiquite and a plug of ijolite. These intrusions are related to the large bodies of alkali rocks which form the core of the San Carlos Mountains to the south of El Mulato. Some of the titaniferous augite and basic plagioclase of the teschenite sills had crystallized at the time of the intrusion, as shown by their occurrence as phenocrysts in the chilled borders. Petrographic examination fails to show any gravitational differentiation, but during the emplacement of the teschenite cumuloporphyritic aggregates of alkali gabbro were formed. After crystallization of the main portion of the teschenite sills small dikelets as fracture fillings were formed in them. These dikelets are restricted to the coarse central parts of the teschenite sills and are not found in the enclosing country rock of shale. They are composed of the later crystallizing minerals of the teschenite and represent differentiation in place within the sills. The dikelets are of analcite monzonite and alkali bostonite.

R. B. McCormick: *Paragonite from Pizzo Forno, Ticino, Switzerland.* "Paragonite" schist containing cyanite and staurolite from the type locality Pizzo Forno, near Faido, Ticino, Switzerland, was analyzed by x-ray, chemical and optical methods. X-ray analysis and optical measurements indicate muscovite and partial chemical analysis shows only 37% of the paragonite molecule present in the micaceous ground mass of the schist.

The reading of the papers was completed at 3:25 P.M. Dr. A. L. Parsons moved that the thanks of the Society be given to the Department of Geology and Mineralogy of the University of Chicago for their enjoyable entertainment and for the excellent provisions made for the meetings.

With no further business to come before it, Prof. Phillips declared the meeting adjourned at 3:30 P.M.

At various times during the sessions of the Society, the following persons registered their attendance. In addition there were many others whose names were not recorded:

A. E. Alexander
W. S. Bayley
Richard L. Barrett
H. Berman
Walter Y. Cox
M. V. Denny
T. A. Dodge
R. C. Emmons
George T. Faust
G. W. Field
D. Jerome Fisher
A. Henry Fretz
Iva N. Frinzel
Jewel J. Glass
O. R. Grawe
John W. Gruner
E. M. Grunnell
E. P. Henderson
W. F. Hunt
C. S. Hurlburt, Jr.
W. D. Keller
Paul F. Kerr
E. H. Kraus
K. K. Landes
Esper S. Larsen
John T. Lonsdale
Wm. J. McCaughey
R. B. McCormick
F. S. Miller
E. C. Olson
A. L. Parsons
Albert B. Peck
A. H. Phillips
J. J. Runner
J. F. Schairer
W. T. Schaller
W. D. Shipton
C. B. Slawson
Duncan Stewart, Jr.
Marcellus H. Stow
C. R. Swartzlow
W. A. Tarr
Mrs. W. A. Tarr
T. H. Taylor
E. Thomson
George Tunell
T. L. Walker
Elizabeth E. Ward
E. H. Watson
A. N. Winchell
H. Winchell
John E. Wolff
Walter J. Yeaton

LIST OF FORMER OFFICERS AND MEETINGS, WITH DATES

By recommendation of the Council, a complete list of past officers is printed in the proceedings of the annual meeting of the Society.

HONORARY PRESIDENT for life.....................Edward S. Dana, 1925

Presidents

1920 Edward H. Kraus
1921 Charles Palache
1922 Thomas L. Walker
1923 Edgar T. Wherry
1924 Henry S. Washington
1925 Arthur S. Eakle
1926 Waldemar T. Schaller
1927 Austin F. Rogers
1928 Esper S. Larsen
1929 Arthur L. Parsons
1930 Herbert E. Merwin
1931 Alexander H. Phillips
1932 Alexander N. Winchell
1933 Herbert P. Whitlock

Vice-Presidents

1920 Thomas L. Walker
1921 Waldemar T. Schaller
1922 Frederick A. Canfield
1923 George F. Kunz
1924 Washington A. Roebling
1925 Herbert P. Whitlock
1926 George Vaux, Jr.
1927 George L. English
1928 Lazard Cahn
1929 Edward Wigglesworth
1930 John E. Wolff
1931 William F. Foshag
1932 Joseph L. Gillson
1933 Frank N. Guild

Secretaries

1920–1922 Herbert P. Whitlock
1923–1933 Frank R. Van Horn
1933 Albert B. Peck

Treasurers

1920–1923 Albert B. Peck
1924–1929 Alexander H. Phillips
1929–1930 Albert B. Peck
1931– Waldemar T. Schaller

EDITORS

1920–1921 Edgar T. Wherry
1922– Walter F. Hunt

COUNCILORS

1920 Arthur S. Eakle, Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips
1921 Frank R. Van Horn, Fred E. Wright, Alexander H. Phillips, Austin F. Rogers
1922 Fred E. Wright, Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson
1923 Alexander H. Phillips, Austin F. Rogers, Thomas L. Watson, Esper S. Larsen
1924 Austin F. Rogers, Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons
1925 Thomas L. Watson, Esper S. Larsen, Arthur L. Parsons, William F. Foshag
1926 Esper S. Larsen, Arthur L. Parsons, William F. Foshag, William A. Tarr
1927 Arthur L. Parsons, William F. Foshag, William A. Tarr, Alexander N. Winchell
1928 William F. Foshag, William A. Tarr, Alexander N. Winchell, Ellis Thomson
1929 William A. Tarr, Alexander N. Winchell, Ellis Thomson, Clarence S. Ross
1930 Alexander N. Winchell, Ellis Thompson, Clarence S. Ross, Paul F. Kerr
1931 Ellis Thomson, Clarence S. Ross, Paul F. Kerr, William S. Bayley
1932 Clarence S. Ross, Paul F. Kerr, William S. Bayley, William J. McCaughey
1933 Paul F. Kerr, William S. Bayley, William J. McCaughey, Kenneth K. Landes

ANNUAL MEETING PLACES

1920 Chicago, Illinois
1921 Amherst, Massachusetts
1922 Ann Arbor, Michigan
1923 Washington, D. C.
1924 Ithaca, New York
1925 New Haven, Connecticut
1926 Madison, Wisconsin
1927 Cleveland, Ohio
1928 New York, New York
1929 Washington, D. C.
1930 Toronto, Canada
1931 Tulsa, Oklahoma
1932 Cambridge, Massachusetts
1933 Chicago, Illinois

NOTES AND NEWS

TEACHING FELLOWSHIP IN MINERALOGY

A teaching fellowship in mineralogy has been established at Stanford University. This fellowship is open to graduate students who intend to specialize in mineralogy and preference will be given to those who have had one or two years of graduate work. The chief duty of the fellow is to assist in laboratory instruction. Not more than eight or nine hours work a week will be required. The amount of the fellowship is $750.

Application for the year 1934–35, accompanied by testimonial letters, should be made to Professor Austin F. Rogers, Box 87, Stanford University, California.